Embedded Solutions

D602 - 6U CompactPCI® PowerPC® Safe Computer

- **3x PowerPC® 750 (lockstep mode), 3x 512 MB DDR RAM**
- **Fail-operational, fault-tolerant behavior**
- **Fail-safe and fail-silent board architecture**
- **Clustering of two D602 to raise availability**
- **Board management, BITE**
- **SEU (radiation) tolerant**
- **Certifiable up to SIL 4 (with report from TÜV Süd) and DAL-A**
- **Developed according to RTCA DO-254, EN 50129 and IEC 61508**
- **EN 50155 compliance**
- **Up to -40 to +70°C with qualified components**
- **Convection or conduction cooling**

The D602 is a 6U CompactPCI® COTS computer with onboard functional safety that realizes triple redundancy on a single board to achieve fail-operational, fault-tolerant behavior. The board can also act as a fail-silent subsystem, i.e. it can shut down in case of a fatal fault. Its complex FPGA-based design helps dramatically lower software development costs as it automatically manages the system's triple-redundant processors and memory. The result: The system's redundant architecture is fully taken advantage of by software designed for a standard single-CPU card. The D602 is designed for deterministic operation and offers extensive BITE features (e.g., ECC error counters for all types of memory, monitoring of all internal voltages), internal buses with error correction and fault-tolerant (fail-operational) implementation. Its three processors run in lockstep mode with 2-out-of-3 (2oo3) voting implemented in FPGA and software-assisted resynchronization, while its triple redundant dynamic memory automatically corrects upsets caused by cosmic radiation (SEU) and hardware faults. The system is powered by redundant local power supplies with separate power supplies for the three CPUs and the three main memory ranks. The D602 has been developed according to DO-254, compliant to DO-160 and certifiable up to DAL-A in avionics applications. Additionally, the product meets the requirements of EN50128/EN50129 and can be deployed in signalling and rolling stock applications up to SIL 4. All I/O is realized in SEU-resistant FPGAs and available on the system's rear connectors. Additionally, the D602 offers two PMC slots (product revisions -02 and later with rear I/O for PMC1). As an option, the second PMC slot can be customized for an AFDX® PMC (rear I/O only). A second D602 can be connected to build a high reliability/availability cluster. The two D602s exchange data via a sextuple UART connection and a BMCX link.

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Technical Data

CPU
- 3x PowerPC® 750 CL
  - Scalable performance
  - 1 GHz processor core frequency
  - Superscalar
  - Classic PowerPC® FPU, MMU
  - CPU bus to FPGA: 100-MHz/64-bit
- Lock-step operation
  - All CPUs do the same thing at the same time
  - 2-out-of-3 voting in FPGA with CPU bus clock speed (100MHz)
  - Software-assisted resynchronization
  - No functional interruption in case of an SEU inside the CPU
- Chipset
  - North- and Southbridge realized in FPGA

Memory
- 2x 32 kB L1 cache, 1MB L2 cache integrated in each CPU
- 3 independent ranks of 512MB DDR SDRAM system memory, FPGA-controlled
  - 100MHz memory bus frequency (32 bit)
  - Up to 800 MB/s
  - 2-out-of-3 voting in FPGA
  - Scrubbing to prevent accumulation of SEU
  - No functional interruption in case of an SEU inside the memory
- 2 independent ranks of 256MB Flash, FPGA-controlled
  - Primary and backup Flash ranks contain the same data, auto-selection by boot loader
  - ECC protection
- 1MB FRAM
  - ECC protection
- 4KB serial EEPROM for production data (serial number etc.)

I/O
- All I/O realized in FPGA and available at rear I/O
- Sextuple UART
  - E.g., for communication with other D602
  - Data rates up to 460,800 Baud for each channel
  - Handshake lines: none
- RS232 UART
  - Data rates up to 460,800 Baud
  - 2x 256 Byte transmit/receive buffer
  - Handshake lines: none
- PCI bus
- I²C bus

Mezzanine Slots
- Two PMC slots
  - 32 bit/33 MHz, 3.3V V(I/O)
  - PMC slot 1 with rear I/O (revisions -02 and later)

Miscellaneous
- Voltage monitoring
- Temperature monitoring
- Watchdog
- Reset signal control
- Control of redundant power supplies
- Sleep mode
  - Lowers power consumption in case of primary power supply interruption
  - Power failure indicated through signals from backplane
  - Supports power interruptions specified in Airbus directive ABD0100.1.9
  - CPUs and memory can be put into sleep mode
- Redundant clock generation
- Connection with second D602 possible (with special backplane)
  - Control of shared outputs
  - Exchange of state information
  - BMC and 6x UART link

CompactPCI® Bus
- Compliance with CompactPCI® Core Specification PICMG 2.0 R3.0
- System slot
- 32-bit/33-MHz PCI-to-PCI bridge
- V(I/O): +3.3V

Electrical Specifications
- Dual power input from CompactPCI® bus, uninterrupted (EN50155, Class S1)
  - 3.3V (-5%/+5%)
  - 5V (-3%/+5%)
  - Standard backplane supplies both input rails with power
  - Continued operation if one power input fails (or is not present)
  - Separate power supplies for the three CPUs and the three main memory ranks
- Supply voltage/power consumption:
  - 30W
  - 15W in sleep mode

Mechanical Specifications
- Dimensions: conforming to CompactPCI® specification for 6U boards
- Front panel: 4HP with ejector
- Weight: 640g (with heat sink)

Environmental Specifications
- Temperature range (operation):
  - 1-slot models: -40..+50°C (qualified components), temperature classes T1, T2, and TX inside buildings, or in containers with temperature control for signalling equipment, according to EN 50125-3, table 2

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Technical Data

  - 2-slot models: -40..+70°C (qualified components), temperature classes T1, T2, and T3 for equipment onboard rolling stock, according to EN 50125-1, table 2
  - Airflow: min. 2 m/s
- Temperature range (storage): -40..+85°C
- Relative humidity (operation): max. 95% non-condensing
- Relative humidity (storage): max. 95% non-condensing
- Altitude: -300m to +2,000m (EN50124, Class AX)
- Compliant to EN50125-1, meeting requirements of EN61373, Cat. 1, Class B and Classes GTX, GL3 for rolling stock
  - Shock: 50 m/s², 30 ms (EN 61373)
  - Vibration (function): 1 m/s², 5 Hz - 150 Hz (EN 61373)
  - Vibration (lifetime): 7.9 m/s², 5 Hz - 150 Hz (EN 61373)
- For signalling equipment, a distance of 3m from the track bed is required
- Protection class IP00 (EN50124, Category PD1)
- Conformal coating on request
- All components soldered

MTBF

- 46 000 h @ 40°C according to MIL.HDBK-217FN2 with modifications.
  - Weighted mean figure for 65% operation in AIC (air inhabited cargo) and 35% operation in GF (ground fixed) conditions
- 312 437 h @ 40°C according to IEC/TR 62380 (RDF 2000)
- 430 705 h for continuous operation @ 25°C according to IEC/TR 62380 (RDF 2000)

Safety

- Erroneous behavior of CPU/memory subsystem < 1E-8 / h
  - Considering hardware failures and worst-case SEU environment
- PCB manufactured with a flammability rating of 94V-0 by UL recognized manufacturers

EMC Conformity

- EN55011 (radiated emission disturbances - rolling stock)
- EN 61000-6-4 (radiated emission disturbances - signalling equipment)
- EN 61000-4-3 (electromagnetic field immunity)
- EN61000-4-2 (electrostatic discharge immunity)
- EN61000-4-8 (power - frequency magnetic field)
- EN61000-4-9 (pulsed magnetic field)

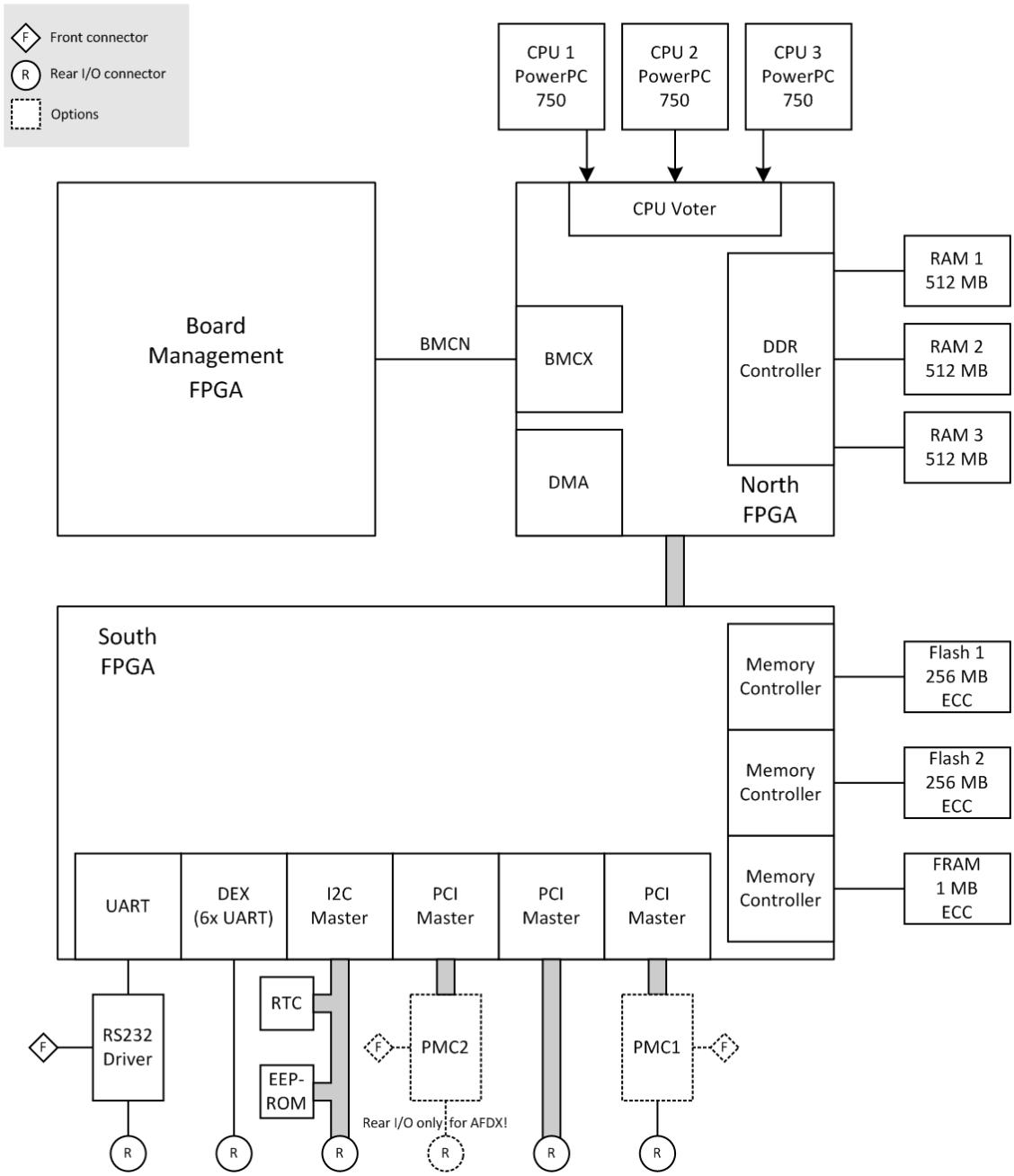
BIOS

- MENMON™

Software Support

- VxWorks®, VxWorks®/Cert
- PikeOS

Diagram


Front connector
Rear I/O connector
Options
CPU 1 PowerPC 750
CPU 2 PowerPC 750
CPU 3 PowerPC 750
CPU Voter
Board Management FPGA
BMCN
BMCX
DMA
DDR Controller
North FPGA
RAM 1 512 MB
RAM 2 512 MB
RAM 3 512 MB
South FPGA
Memory Controller
Memory Controller
Memory Controller
Flash 1 256 MB ECC
Flash 2 256 MB ECC
FRAM 1 MB ECC
UART
DEX (6x UART)
I2C Master
PCI Master
PCI Master
PCI Master
RS232 Driver
RTC
EEP-ROM
PMC2
Rear I/O only for AFDX!
PMC1
F
R

Configuration & Options

Standard Configurations

Article No.	CPU Type	Clock	System RAM	Flash	FRAM	PMC Slots	Width	Cooling	Operating Temperature
02D602-03	3x PPC 750 CL	1 GHz	3x 512 MB	2x 256 MB	1 MB	2	4 HP	Convection (air flow 2 m/s)	-40..+50°C

Options

Mezzanine Slots

- PMC slot 2 customized for AFDX® PMC (rear I/O only)

Real-time Clock

- Buffered by GoldCap

Environmental Specifications

- Temperature range (operation):
  - -40..+70°C (8HP front panel with convection cooling or 4HP front panel with conduction cooling)

Cooling Concept

- Also available with conduction cooling in MEN CCA frame

Please note that some of these options may only be available for large volumes. Please ask our sales staff for more information.

Ordering Information

Standard D602 Models

02D602-03 3x PowerPC® 750CL, 1 GHz, 3x 512 MB DRAM, 2x 256 MB Flash, 1 MB FRAM, 2 standard, PMC slots, convection cooling (airflow 2 m/s), -40 to +50°C with qualified components

Related Hardware

15P511-00 Dual Fast Ethernet, 2 Ethernet cores, 6 GPIO signals, front I/O, for convection cooled systems, -40..+85°C with qualified components

Miscellaneous Accessories

05P000-01 25 mounting screw sets to fix PMC/XMC modules on carrier boards

08AE33-00 A602/D602 debug adapter to connect debug terminal, JTAG equipment and Freescale™ CodeTest Probe, -40..+85°C with qualified components

08CT14-00 Rear I/O adapter D602 without front panel; with RS232, PMC rear I/O, 6x DEX UART, BMCX, AFDX®, debug signals, -40..+85°C with qualified components

Software: VxWorks

This product is designed to work under VxWorks®. For details regarding supported/unsupported board functions please refer to the corresponding software data sheets.

10D602-60 VxWorks® BSP (MEN) for A602 and D602

In addition, this product is supported by Wind River's market-specific OS products VxWorks® 653, VxWorks® DO-178B and VxWorks® 61508. These are certifiable platforms for use in safety and mission-critical systems. For more information and product support please contact MEN or Wind River.

Software: PikeOS

This product is designed to work under PikeOS by Sysgo. PikeOS is a real-time operating system for use in safety and mission-critical systems. For more information and product support please contact www.sysgo.com.

Software: Firmware/BIOS

MENMON™ is MEN's firmware/BIOS for PowerPC® platforms.

14D602-00 MENMON™ (Firmware) for D602 (object code)

For operating systems not mentioned here contact MEN sales.

Documentation

Compare Chart 6U CompactPCI® cards Download

If required for your project MEN offers an EN 50129 compliant certification package which can be purchased in combination with the hardware. It includes: SIL 4 Certificate TÜV Assessment Report Safety Case describing the concepts for reaching functional safety as well as all safety and quality-relevant processes and measures to meet the SIL 4 requirements. Technical Safety Report User Manual including the safety-relevant application requirements beside a detailed description of the hardware and the usual instructions for appropriate operation Please contact us to get more information about the certification package and to request a copy of the documents. For more information on the architecture of safe computers, please read our white paper Ready for SIL 4: Modular Computers for Safety-Critical Mobile Applications, available in English and German.

Compare Chart safe computers from MEN Download

For the most up-to-date ordering information and direct links to other data sheets and downloads, see the D602 online data sheet under » www.men.de.

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Contact Information

Germany
MEN Mikro Elektronik GmbH
Neuwieder Straße 3-7
90411 Nuremberg
Phone +49-911-99 33 5-0
Fax +49-911-99 33 5-901
E-mail info@men.de
www.men.de

France
MEN Mikro Elektronik SA
18, rue René Cassin
ZA de la Châtelaine
74240 Gaillard
Phone +33 (0) 450-955-312
Fax +33 (0) 450-955-211
E-mail info@men-france.fr
www.men-france.fr

USA
MEN Micro, Inc.
24 North Main Street
Ambler, PA 19002
Phone (215) 542-9575
Fax (215) 542-9577
E-mail sales@menmicro.com
www.menmicro.com

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